CLAIMS

What is claimed is:

1. An automatic image cropping system for use with a portable device having an image capture mechanism and a limited resource for storing or transmitting captured information, the system comprising a region of interest suggestion engine defining plural image region candidates by performing image segmentation on an image stored in digital form, determining if an image region candidate is likely to be more or less interesting to a user than another image region candidate, and selecting an image region candidate determined as likely to be of most interest to the user.

2. The system of claim 1, wherein said region of interest suggestion engine measures entropies of the image region candidates and uses entropy thus measured as a measure of likelihood of user interest.

3. The system of claim 2, wherein said region of interest suggestion engine computes a cost *C* according to:

$$C = \frac{\alpha}{H_H + H_U + H_V} + \frac{\beta}{A_{ratio}} + \gamma\left(\frac{|X_c - I_{cx}|}{w} + \frac{|Y_c - I_{cy}|}{h}\right)$$

where H_H, H_U, H_V are entropies of sub-images H, U and V respectively, $A_{ratio} = \frac{Area_{ROI}}{Area_{image}}$ is an area ratio of an image region candidate and a common viewing area of the image, X_c, Y_c is a center of the image region candidate, I_{cx}, I_{cy} is a center of the common viewing area of the image, *w* ,*h* are width and height of a lens viewing area, and α, β, γ are normalizing weights.

4. The system of claim 3, wherein said region of interest suggestion engine initializes parameters α, β, γ to empirically normalize and balance all three components that contribute to the cost: entropy (E), area ratio (A) and center distance (D), generates lists of the image region candidates according to E, A, D and their total cost: αE + βA + γD, suggests the image region candidates by making them available for viewing and selection, analyzes components E, A, D on an image region candidate selected by the user, and adjusts parameters α, β, γ accordingly.

5. The system of claim 3, wherein said region of interest suggestion engine deems an image region candidate having a lowest cost *C*

thus computed as likely to be of greatest interest to the user relative to other image region candidates.

6. The system of claim 3, wherein parameters α, β, γ are selected based on characteristics of an image capture device.

7. The system of claim 3, wherein parameters α, β, γ are selected based on habits of the user.

8. The system of claim 2, wherein said region of interest suggestion engine measures entropy of an image region candidate according to:

$$H = -\sum_{i} h(i) \log_2 h(i)$$

where h(i) $i \in I$ is a histogram of the image region candidate.

9. The system of claim 1, wherein said region of interest suggestion engine segments the image based on image texture and color consistency.

10. The system of claim 9, wherein said region of interest suggestion engine uses vectors calculated from Wavelet transform to represent texture information.

11. The system of claim 1, wherein said region of interest suggestion engine employs a fuzzy k-mean clustering method to perform the image segmentation.

12. The system of claim 11, wherein said region of interest suggestion engine uses features in the clustering method derived on color differences of neighboring pixels *i* and *j* defined according to:

$$C_{diff}(i, j) = \sqrt{(h(i) - (h(j))^2 + (u(i) - u(j))^2 + (v(i) - v(j))^2}$$

where *h(i)*, *u(i)* and *v(i)* are an HUV value of pixels *i* and *h(j)*, *u(j)* and *v(j)* are an HUV value of pixel *j*.

13. The system of claim 1, wherein said region of interest suggestion engine performs color transformation on an image stored in digital form.

14. The system of claim 13, wherein said region of interest suggestion engine transforms an image in RGB format into HUV (Hue, Saturation and Intensity) format.

15. The system of claim 1, wherein said region of interest suggestion engine measures sizes of image region candidates relative to a common viewing area of the image and uses relative size thus measured as a measure of likelihood of user interest.

16. The system of claim 1, wherein said region of interest suggestion engine measures locations of image region candidates relative to a common viewing area of the image and uses relative location thus measured as a measure of likelihood of user interest.

17. The system of claim 1, wherein said region of interest suggestion engine pre-processes the image to eliminate noise in blurred text histograms to smooth the image.

18. The system of claim 1, further comprising a graphic user interface initially giving a focus to the image region candidate selected by said region of interest suggestion engine, displaying an image region candidate having the focus with a first display property visually distinguishable from a second display property employed to simultaneously display image region candidates not having the focus, shifting focus between displayed image region candidates in response to user navigation selections, and excluding image contents outside an image region candidate having the focus in response to user confirmation of the image region candidate having the focus.

19. The system of claim 18, wherein said image region suggestion engine ranks image region candidates according to likelihood of user interest, and said graphic user interface shifts the focus between image region candidates based on ranking of the image region candidates.

20. The system of claim 1, wherein the engine further comprises a training module to track user interaction with the portable device and adjust future determination of likelihood of user interest accordingly.

21. The system of claim 1, wherein said engine uses camera sensor data to determine likelihood of user interest.

22. An automatic image cropping method, comprising:

performing image segmentation on an image stored in digital form, thereby defining plural image region candidates;

determining if an image region candidate is likely to be more or less interesting to a user than another image region candidate; and

selecting an image region candidate determined as likely to be of most interest to the user.

23. The method of claim 22, further comprising measuring entropies of the image region candidates and using entropy thus measured as a measure of likelihood of user interest.

24. The method of claim 23, further comprising computing a cost *C* according to:

$$C = \frac{\alpha}{H_H + H_U + H_V} + \frac{\beta}{A_{ratio}} + \gamma\left(\frac{|X_c - I_{cx}|}{w} + \frac{|Y_c - I_{cy}|}{h}\right)$$

where H_H, H_U, H_V are entropies of sub-images H, U and V respectively, $A_{ratio} = \frac{Area_{ROI}}{Area_{image}}$ is an area ratio of an image region candidate and a common viewing area of the image, X_c, Y_c is a center of the image region candidate, I_{cx}, I_{cy} is a center of the common viewing area of the image, *w* ,*h* are width and height of a lens viewing area, and α, β, γ are normalizing weights.

25. The method of claim 24, further comprising:

initializing parameters α, β, γ to empirically normalize and balance all three components that contribute to the cost: entropy (E), area ratio (A) and center distance (D);

generating lists of the image region candidates according to E, A, D and their total cost: αE + βA + γD;

suggesting the image region candidates by making them available for viewing and selection; and

analyzing components E, A, D on an image region candidate selected by the user and adjusting parameters α, β, γ accordingly.

26. The method of claim 24, further comprising deeming an image region candidate having a lowest cost *C* thus computed as likely to be of greatest interest to the user relative to other image region candidates.

27. The method of claim 24, further comprising selecting parameters α, β, γ based on characteristics of an image capture device.

RECTIFIED SHEET (RULE 91)

28. The method of claim 24, further comprising selecting parameters α, β, γ based on habits of the user.

29. The method of claim 23, further comprising measuring entropy of an image region candidate according to:

$$H = -\sum_{i} h(i) \log_2 h(i)$$

where h(i) $i \in I$ is a histogram of the image region candidate.

30. The method of claim 22, further comprising suggesting the selected image region candidate to a user.

31. The method of claim 30, further comprising receiving a user confirmation of the selected image region candidate.

32. The method of claim 31, further comprising processing the image based on the user confirmation.

33. The method of claim 31, further comprising segregating the selected image region candidate from at least one other part of the image in response to receipt of the user confirmation.

34. The method of claim 31, further comprising saving the selected image region candidate absent image contents external to the selected image region in response to receipt of the user confirmation.

35. The method of claim 31, further comprising transmitting the selected image region candidate absent image contents external to the selected image region in response to receipt of the user confirmation.

36. The method of claim 31, further comprising zooming in on the image region candidate in response to receipt of the user confirmation.

37. The method of claim 30, further comprising:

receiving a user contradiction of the selected image region candidate; and

selecting a new image region candidate determined as most likely to be of most interest to the user based on the user contradiction.

38. The method of claim 22, further comprising segmenting the image based on image texture and color consistency.

39. The method of claim 38, further comprising using vectors calculated from Wavelet transform to represent texture information.

RECTIFIED SHEET (RULE 91)

40. The method of claim 22, further comprising employing a fuzzy k-mean clustering method to perform the image segmentation.

41. The method of claim 40, further comprising using features in the clustering method derived on color differences of neighboring pixels *i* and *j* defined according to:

$$C_{diff}(i,j) = \sqrt{(h(i)-(h(j))^2 + (u(i)-u(j))^2 + (v(i)-v(j))^2}$$

where *h(i)*, *u(i)* and *v(i)* are an HUV value of pixels *i* and *h(j)*, *u(j)* and *v(j)* are an HUV value of pixel *j*.

42. The method of claim 22, further comprising performing color transformation on an image stored in digital form.

43. The method of claim 42, further comprising transforming an image in RGB format into HUV (Hue, Saturation and Intensity) format.

44. The method of claim 22, further comprising measuring sizes of image region candidates relative to a common viewing area of the image and using relative size thus measured as a measure of likelihood of user interest.

45. The method of claim 22, further comprising measuring locations of image region candidates relative to a common viewing area of the image and using relative location thus measured as a measure of likelihood of user interest.

46. The method of claim 22, further comprising capturing an image in digital form.

47. The method of claim 22, further comprising pre-processing the image to eliminate noise in blurred text histograms to smooth the image.

48. The method of claim 22, further comprising tracking user interaction with the portable device and adjusting future determination of likelihood of user interest accordingly.

49. The method of claim 22, further comprising using camera sensor data to determine likelihood of user interest.

RECTIFIED SHEET (RULE 91)